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Cytology Is Advanced by Studying Effects of Deuterium Environment

A study of the effects of deuterium (heavy water) on biological systems has been presented in a concise and comprehensive report. This report, covering the period 1933 to 1964, summarizes the earliest work and presents a detailed discussion of more recent research. Discussion is concerned primarily with events at the cellular level, with particular emphasis on the growth characteristics of microorganisms and higher plants in deuteriated media.

The report is divided into four technical sections: (1) growth of microorganisms in deuterium (D_2O); (2) growth of higher plants in D_2O ; (3) cytology; and (4) genetic effects. Section (1) includes bacteria, fungi, protozoa, cells in tissue culture, and viruses. "Cytochemistry of Deuteriated Cells" and "Effects of Deuterium on Cell Division" constitute the cytology section.

Early studies on the biological effects of deuterium, in the years immediately following its discovery in 1932, resulted in confusing data. The main conclusion derived from these studies is that high concentrations of deuterium are incompatible with cellular growth.

Unicellular green algae were the first fully deuteriated organisms. To deuteriate these organisms, the exchangeable hydrogen in $-OH$, $-NH_2$, and $-COOH$ groups, as well as the nonexchangeable $C-H$ bonds, were replaced by deuterium. Successful autotrophic growth of the algae in 99.8% D_2O resulted, which proved that extensive deuteriation is not incompatible with life, and led to the culture of a wide variety of fully deuteriated heterotrophic microorganisms.

A number of bacteriological species have been successfully cultured. Variations in cell size of 0.2 to 13 microns were noted in the adaptation of these organisms to an environment of 40% to 60% D_2O . Overall, effects of deuterium include "abnormal" variations in lag phase generation time, acetyl-methyl-

carbinal content of cells, pigment production, nitrogen fixing capacity, oxygen consumption and size of cell.

With the successful cultivation of fully deuteriated bacteria, attention has been focused on the deuterio-compounds that can be extracted from the bacteria. DNA has been successfully isolated from such bacteria and its properties have been studied. Certain photosynthetic bacteria have provided a source of deuterio-bacteriochlorophyll. The induced formation of the enzyme β -galactosidase has been studied in fully deuteriated *E. Coli* strain. Thus, it is now feasible to study enzyme reactions in which deuteriated enzymes act on ordinary and deuterio-substrates.

The effects of deuterium differ greatly with each biological system, and much more research is necessary to realize possible applications. The successful cultivation of fully deuteriated organisms, however, is a breakthrough which should lead to many other areas of investigation.

Notes:

1. Additional details are contained in: *International Review of Cytology*, vol. 18, 1965, p. 313-361, Academic Press Inc., New York.
2. Inquiries concerning this innovation may be directed to:

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(continued overleaf)

Patent status:

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